IMPLICATIONS FOR VENUSIAN PLAINS RESURFACING FROM GEOMORPHIC MAPPING AND IMPACT CRATER DENSITIES. S. A. Hauck, II[1] , R. J. Phillips[1], and M. Price[2] ;[1]Washington University, Campus Box 1169, One Brookings Drive, St. Louis, MO 63130 hauck@wudere.wustl.edu,[2]South School of Mines and Technology, Rapid City, SD 57701.

Introduction Two main lines of evidence are most often cited when describing a possible mechanism for Venusian resurfacing. First and most importantly, the impact crater distribution cannot be distinguished from one that is completely spatially random (CSR) [1,2]. Second, there is a dearth of volcanically embayed craters on the surface [1,2,3].

While there are other lines of evidence, these two observations have been the linchpin of an accepted paradigm in Venusian resurfacing [2,3], the catastrophic resurfacing model. The catastrophic model implies a rapid, large scale lava flooding and tectonic event, which would have erased all evidence of earlier craters, followed by the cessation, or at least rapid waning, of resurfacing activity on Venus. Original thinking on the catastrophic hypothesis suggested that the resurfacing tailed off in ~10 Myr. [2,3]; new work suggests this period may have lasted as long as 100 Myr. [4]. While this conclusion is by far the most simple, it is certainly not a unique interpretation of the evidence.

Using data from Magellan synthetic aperture radar (SAR), Price and Suppe [5] used the lobateness of lava flows and their characteristic radar brightness to hypothesize that plains units of distinctly different ages could be mapped. The four plains units: PL1, PL2, PL3, and PS are the most significant in that they are the most extensive feature (>60% by area). Price et al. [6] tested their hypothesis by showing that the four units have statistically distinct crater production ages. Other studies [7,8], have used impact crater densities in this way to constrain rifting and volcanism on Venus. Even though the definition of the units was based upon morphologic rather than stratigraphic criteria, and the actual production ages may overlap between units, the different production ages imply that, *on average*, surface ages increase as lobateness and brightness decrease. However, Basilevsky and Head [9] compared their stratigraphic units with the plains units of [5] and concluded that the plains units capture the overall age progression, yet they cannot distinguish fine-scale details. It is also important to note that lack of resolution of the geomorphic indexing precludes the mapping of sub-units within each of the four plains units; this may be particularly significant in PS due to saturation effects [10].

Models The average apparent production age of Venus' surface (T) has been estimated by Phillips et al. [1] to be approximately 500 Myr. and Strom et al. [3] to be on the order of 300 Myr. New, more rigorous work by McKinnon et al. [11] has extended this age estimate to be about 700-800 Myr.

Using a database of 926 impact craters that match the plains and all other areas of the planet mapped by Price [5] we calibrated the relative ages of the plains units using 800 Myr. from [11]. The results are given in Table 1.

Unit	Relative Age	Age using [11] (Myr)
PL1	0.83±0.38T	664±304
PL2	0.91±0.15T	728±120
PL3	1.21±0.16T	968±136
PS	1.38±0.16T	1104±136

Table 1 Relative ages of Venusian plains units, errors are 2σ. T is the average surface production age.

Inasmuch as these units together comprise a majority of the planetary surface, and they all appear to post-date major tessera forming activity, they are particularly indicative of Venus' recent resurfacing style. It is apparent from these results, that even if the plains represent a catastrophic resurfacing event that it may have extended over a considerable period of time, perhaps on the order of 0.5 Gyr. Furthermore, it has been argued recently that tessera ages are older than the oldest plains units by uncertain amounts [12]. Each of these lines of evidence suggest another scenario for the resurfacing history of Venus that is quite different from a catastrophic model.

In order to test the hypothesis that Venus could have been resurfaced over four widely spread periods without disrupting CSR, we modeled this process using Monte Carlo techniques. The entire planetary surface was bombarded with craters from a spatially random probability sampling. However, each unit was assumed to represent a single resurfacing event that occurs instantaneously in time such that craters entrained in the model are consistent with the data. The result is a planetary surface with the same number of craters as are observed, and in the same proportions by geomorphic unit (hence they have the 400+ Myr spread in production age given in Table 1). The question is: can the model be distinguished from CSR?

Results In order to answer the previous question, we performed the same spatial randomness tests as Phillips et al. [1]. We have examined the individual nature of over 200 model runs and as a single Monte Carlo exercise. Each individual run cannot be distinguished from CSR. In addition, the entire ensemble is in general agreement with the results of a model that randomly emplaces craters on a single fresh surface with no subsequent resurfacing activity. This is illustrated in the QQ and PP plots in Figures 1 and 2. In other words, a Venus with the four distinct production ages of each of the plains units leads to a global crater population that cannot be distinguished from CSR.

In order to examine the sensitivity of this method we intentionally perturbed the relative ages of two plains units and ran our models again. First, the age of PS was increased by 2σ and PL3 was decreased by 2σ. In the second test PL2 was decreased. The intent was to examine how disparate the ages of the units could be (i.e. length of resurfacing interval) before the model was no longer valid. The perturbations do not significantly alter the results.

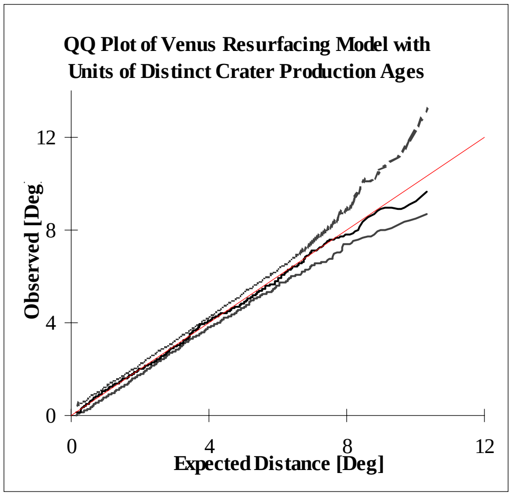

Figure 1 QQ Plot of resurfacing model.

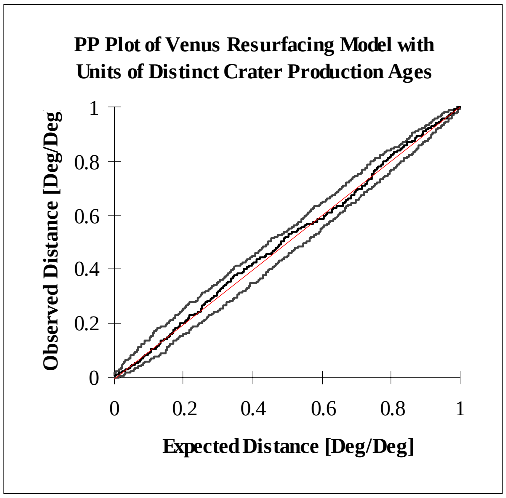

Figure 2 PP Plot of resurfacing model.

Conclusion These results indicate that there are other viable models for the plains resurfacing history of Venus. The results of the perturbed age models suggest that resurfacing over a significant length of time is not implausible. In order to more strongly test the validity of this hypothesis it will be necessary to conclude our studies by examining how this model affects the expected number of volcanically embayed craters. Preliminary results suggest that this model may result in a small number of embayed craters, similar to the quantity observed in the Venusian plains.

The popularly held [13] catastrophic model lacks the more robust nature of a model that includes knowledge of Venusian geology. Hopefully we are one step closer to revealing the resurfacing history of Venus.

References

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